CORRUGATED FIN

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention belongs to a technical field of a corrugated fin for composite heat exchangers.

2. DESCRIPTION OF THE RELATED ART

The conventional corrugated fin corresponds to required heat release amounts of respective heat exchangers by making the fin width and the number of louver slats different between a condenser side and a radiator side. (For example, refer to Japanese Patent Laid-open No. Hei 10-253276.)

Regarding composite heat exchangers used particularly for motor vehicles, there has been a demand to make thicknesses of the condenser and the radiator which compose the composite heat exchanger different according to diversification of the size of cabin and diversification of required specification of cooling performance in an engine room. In this case, the corrugated fin should be made to have different fin width between the condenser side and the radiator side. However, the conventional corrugated fin have such a problem that, when the fin widths of the corrugated fin integrally formed with corrugated fin of the composite heat exchanger are made different from each other, the entire corrugated fin bend during a corrugating step due to a difference of residual stresses generated in a louver processing step due to a difference of the number of louver slats formed according to the fin width.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a corrugated fin which integrally has two types of fin widths respectively made different corresponding to two types of heat exchangers, the corrugated fins capable of preventing bending of the entire corrugated fin during a corrugating step

thereof due to a residual stress generated in a louver processing step.

Another object of the present invention is to provide a manufacturing method of a corrugated fin which integrally has two types of fin widths respectively made different corresponding to two types of heat exchangers, the corrugated fins capable of preventing bending of the entire corrugated fin during a corrugating step thereof due to a residual stress generated in a louver processing step.

In order to achieve the first object, the corrugated fin according to the present invention comprises: a first and second corrugated fin portions having different fin widths corresponding to two types of heat exchangers and integrally formed next to each other, the fin width (LA) of the first corrugated fin portion being smaller than the fin width of the second corrugated fin portion ; and a first and second louvers provided on each of the first and second corrugated fin portions to extend corresponding to the fin widths of the first and second corrugated fin portions, the first and second louvers respectively having a plurality of louver slats inclined at a predetermined angle, the louver slats respectively having a direction of inclination which is different between each of the first and second corrugated fin portions, and a processed amount per unit width of the second louver being smaller than a processed amount per unit width of the first louver.

On the corrugated fin, the residual stress per unit width generated in a louver processing step is reduced by making the processed amount per unit width of the second louver on the second corrugated fin portion smaller than the processed amount per unit width of the first louver on the first corrugated fin portion. Accordingly, degree of intensity of the residual stress becomes low, and a combination of the larger fin width and the louver having the more louver slats with the residual stress of small intensity can be substantially balanced with a combination of the smaller fin width and the louver having the less louver slats with the residual stress of large intensity, thereby preventing the bending of the entire corrugated fin in a processing step thereafter.

Thus, the two types of corrugated fin portion can be made to have

different fin widths to thereby meet diversified demands for performance.

In the above corrugated fin, an inclination angle of the second louver on the second corrugated fin portion is preferably smaller than an inclination angle of the first louver on the first corrugated fin portion so that the processed amount per unit width of the second louver becomes smaller than the first louver.

This results in that the combination of the larger fin width and the second louver having the more louver slats with the residual stress of small intensity can be substantially balanced with the combination of the smaller fin width and the first louver having the less louver slats with the residual stress of large intensity, thereby preventing the bending of the entire corrugated fins in the processing step thereafter.

Since the second louver on the second corrugated fin portion has the smaller inclination angle, excellent cooling performance can be obtained due to smooth air flow, even though the louver has the large number of louver slats.

Thus, the two types of corrugated fin portions can be made to have different fin widths to thereby meet the diversified demands for performance and improve heat exchange performance.

Further, in the above corrugated fin, a pitch between adjacent louver slats of the second louver formed on the second corrugated fin portion is preferably narrower than a pitch between the adjacent louver slats of the first louver formed on the first corrugated fin portion so that the processed amount per unit width of the second louver becomes smaller than the first louver.

This results in that the combination of the larger fin width and the second louver having the more louver slats with the residual stress of small intensity can be substantially balanced with the combination of the smaller fin width and the first louver having the less louver slats with the residual stress of large intensity, thereby preventing the bending of the entire corrugated fins in the processing step thereafter.

Further, in the above corrugated fin, the second louver of the second

corrugated fin having the larger fin width has an increased heat release area to contact with the air flow, so that the excellent cooling performance can be obtained.

Thus, the two types of corrugated fin portions can be made to have different fin widths to thereby meet the diversified demands for performance and improve heat exchange performance.

Further, on the corrugated fin, the first corrugated fin portion is preferably for automotive condensers, and the second corrugated fin portion is preferably for automotive radiators.

This results in that the fin widths of the condenser portion and the radiator portion of the composite heat exchanger can correspond to respective demands for the cooling performance and to diversified motor vehicles while reducing the cost.

In order to achieve the second object, the manufacturing method of the corrugated fins according to the present invention comprises: a louver processing step to form a first and second louvers in such a manner that on each of a first and second corrugated fin portions have respectively different fin widths corresponding to two types of heat exchangers and integrally formed next to each other, the fin width of the first corrugated fin portion being smaller than the fin width of the second corrugated fin portion, the first and second louvers extending corresponding to the fin widths of the first and second corrugated fin portions and having a plurality of louver slats inclined at a predetermined angle respectively, the louver slats respectively having a direction of inclination which is different between each of the first and second corrugated fin portions, and a processed amount per unit width of the second corrugated fin portion is smaller than a processed amount per unit width of the first corrugated fin portion; and a bend correcting step to correct, after the louver processing step, a bend of entire body of the first and second corrugated fin portions by widening to a predetermined width a wave pitch inside a bending direction of the first and second corrugated fin portions which are formed entirely in a corrugated form

In the manufacturing method of the corrugated fin, when two types of

corrugated fin portions having different fin widths are corrugated to form the corrugated fin, the bend of the corrugated fin is corrected by widening to the predetermined width the wave pitch inside the bending direction of the corrugated fin which tend to bend entirely when corrugated. Accordingly, the bends can be further corrected and minimized, and the two types of the corrugated fin portions can have different fin widths, thereby meeting the diversified demands for performance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an explanatory view showing a part of a composite heat exchanger using corrugated fins of a first embodiment;

FIG. 2 is an enlarged view of the corrugated fins of the first embodiment;

FIG. 3 is a schematic view showing a cross-section of the corrugated fins of the first embodiment;

FIG. 4 is an explanatory view showing a corrugated fin correcting device used for manufacturing the corrugated fin of the first embodiment;

FIG. 5 is a cross-sectional explanatory view of a corrugated fin of a second embodiment; and

FIG. 6A and 6B are explanatory views of manufacturing method of the corrugated fin according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, embodiments for realizing a corrugated fin of the present invention will be described based on the drawings.

(First Embodiment)

First, a structure will be explained.

FIG. 1 is an explanatory view showing a part of a composite heat exchanger using a corrugated fin of a first embodiment. FIG. 2 is an enlarged view of the corrugated fin of the first embodiment. FIG. 3 is a

schematic view showing a cross-section of the corrugated fin of the first embodiment.

As shown in FIG. 1 to FIG. 3, a composite heat exchanger 1 includes plural corrugated fins 2 respectively having a condenser portion 21, and a radiator portion 22, and tubes 3 arranged between these corrugated fins 2.

The first embodiment is an example of the corrugated fins 2 which are used for the composite heat exchanger 1 which comprises a condenser 5 and a radiator 6 arranged in a parallel relationship with each other and mounted in a motor vehicle.

The corrugated fin 2 is, as shown in FIG. 2, integrally formed of the condenser portion 21, corresponding to a first corrugated fin portion of the present invention, used as the corrugated fin of the condenser 5 and the radiator portion 22, corresponding to a second corrugated fin portion of the present invention, used as the corrugated fin of the radiator 6.

Further, in FIG. 2, for the corrugated fin 2, the fin width of the condenser portion 21 is denoted by L_A, the fin width of the radiator portion 22 is denoted by L_B, a wave pitch is denoted by F, a wave height is denoted by h. The fin width L_B of the radiator portion 22 is larger than the fin width L_A of the condenser portion 21.

The corrugated fin 2 with the condenser portion 21 and the radiator portion 22 is formed based on a long plate on which, first, a first louver 211 is formed at a predetermined pitch on the condenser portion 21. The first louver 211 has a plurality of louver slats 211a formed by opening and raising a portion of the long plate corresponding to the fin width L_A of the condenser portion 21, the louver slats 211a being processed to be inclined against the long plate at a predetermined inclination angle A.

In the first embodiment, the number of louver slats 211a of the first louver 211 formed on the condenser portion 21 is 16, and the inclination angle A of the first louver slats 211a is 23° .

Meanwhile, a second louver 221 is formed at a predetermined pitch on the radiator portion 22 of the long plate. The second louver 221 is formed by a plurality of louver slats 221a corresponding to the fin width L_B of the

radiator portion 22, the louver slats being processed to be inclined against the long plate at a predetermined inclination angle B.

In the first embodiment, the number of louver slats 221a of the second louver 221 formed on the radiator portion 22 is 27, and the inclination angle B of the second louver slats 221a is 20°.

Further, the first and second louver slats 211a and 221a of the first and second louver 211 and 221 are inclined in different directions which oppose each other.

The plate on which the first and second louvers 211 and 221 are formed is corrugated by processing to thereby form the corrugated fin 2. Then plural layers of these corrugated fins 2 are arranged between the tubes 3 to compose the composite heat exchanger 1.

Here, in manufacturing the corrugated fin 2, prevention of bending of the corrugated fins 2 during formation of the corrugated fins 2 is, if necessary, carried out as follows.

The first and second louvers 211 and 221 formed on the condenser portion 21 and the radiator portion 22 of the corrugated fin 2 respectively have the different number of louver slats 211a and 221a to be 16 and 27, which causes different residual stresses to remain at processed portions and in the vicinity thereof during processing of forming the louver slats 211a and 221a by opening and rising the portion of the long plate. However, on the corrugated fin 2 in the first embodiment, the second louver slats 221a of the second louver 221 of the radiator portion 22, which are formed so many as 27, have a small inclination angle of 20° so as to make the processed amount of raising the second louver slats 221a smaller than the first louver slats 211a of the first louver 211 of the condenser portion 21. The intensity of the residual stress per unit width is thus adjusted so that the sums of the respective residual stresses of the condenser portion 21 and the radiator portion 22 become approximately equal. This adjustment to the inclination angles of the first and second louver slats 211a and 221a can prevent the bending of the entire corrugated fin 2 during the above mentioned corrugating process thereafter.

After the louver processing step, as shown in FIG. 4, the corrugated fin 2 in the first embodiment are passed through between rollers 41 of a corrugated fin correcting device 4, which has the plural rollers 41 at a predetermined pitch. Consequently, the corrugated fins 2 are obtained with high precision of linearity and the fin pitch is made to be a predetermined width so that the corrugated fin 2 can be precisely assembled to the composite heat exchanger 1 thereafter.

On the thus formed corrugated fin 2, the inclination angle B of the second louver 221 of the radiator portion 22 is small, so the air flows smoothly even when the fin width LB of the radiator portion 22 is made larger, and thus the cooling performance can be improved without impairing the effect of making the fin width LB larger.

The corrugated fin 2 of the first embodiment can provide effects as listed below.

(1) The radiator portion 22 and the condenser portion 21 of the first and second corrugated fin 2 having two different fin widths of the composite heat exchanger 1 for motor vehicles are formed integrally next to each other. The first and second louver slats 211a and 221a are formed by opening and rising process to have numbers of 16 and 27 respectively, corresponding to the fin widths LA and LB on the condenser portion 21 and the radiator portion 22, the first louver slats 211a of the condenser portion 21 is made to be inclined at the inclination angle of 23° , the second louver slats 221a of the radiator portion 22 is made to be inclined at the inclination angle of 20° , and the inclination directions of the first and second louver slats 211a and 221a are made different opposing each other. The bending of the entire corrugated fin 2 is prevented by making the processed amount per unit width of the second louver 221 on the radiator portion 22 having the larger fin width smaller than the processed amount per unit width of the first louver 211 on the first condenser portion 21 having the smaller fin width. Consequently, the two portions 21 and 22 of the corrugated fin 2 can have the different fin widths LA and LB to thereby meet diversified demands for performance.

(2) On the condenser portion 21 and the radiator portion 22 having two different fin widths of the composite heat exchanger 1 for motor vehicles, the condenser portion 21 is inclined at the angle of 23° and the radiator portion 22 is inclined at the angle of 20° , and the angle of the second louver slats 221a of the radiator portion 22 having the larger fin width LB is made smaller than the angle of the first louver slats 211a of the condenser portion 22 having the smaller fin width LA, so that the two portions 21 and 22 are made to have inclination angles corresponding to the different fin widths LA and LB, thereby meeting the diversified demands for performance and improving heat exchange performance.

(4) For the condenser portion 21 of the corrugated fin 2 used for automotive condensers and the radiator portion 22 of the corrugated fin 2 used for automotive radiators, the inclination angles of the first and second louver slats 211a and 221a are set corresponding to the fin widths LA and LB for the condenser 5 and the radiator 6 of the composite heat exchanger 1, thereby corresponding to respective demands for cooling performance and to the diversified motor vehicles while reducing the cost.

(Second Embodiment)

In a second embodiment, as shown in FIG. 5, a condenser portion 21 corresponding to a first corrugated fin portion of the present invention has a fin width PA smaller than a fin width PB of a radiator portion 22 corresponding to a second corrugated fin portion of the present invention. The condenser portion 21 and the radiator portion 22 has a first and second louvers 21 and 22 respectively. The first and second louvers 21 and 22 are formed with a first and second louver slats 211a and 221a respectively. A pitch PB of the second louver slats 221a of the second louver 221 of the radiator portion 22 is made smaller than a pitch PA of a first louver slats 211a of the first louver 21 of the condenser portion 21.

Incidentally, the other structure is the same as that of the corrugated fins 2 of the first embodiment, so the explanation thereof is omitted.

Here, prevention of bending of the corrugated fins 2 during formation of the corrugated fin 2 is, if necessary, carried out as follows.

By narrowing the pitch P_B of the second louver slats 221a of the radiator portion 22 than the pitch P_A of the condenser portion 21, the corrugated fin 2 of the second embodiment reduces a processed amount of raising the second louver slats 221a to a predetermined inclination angle when forming the second louver 221 so as to equalize intensity of residual stress per unit width on the radiator portion 22 with intensity of residual stress per unit width remaining on the condenser portion 21, thereby preventing bending of the corrugated fin 2 during a corrugating step thereafter.

The corrugated fin 2 of the second embodiment can provide the following effects in addition to the effects (1) and (4) of the first embodiment.

(3) By narrowing the pitch P_B between each second louver slats 221a of the second louver 221 of the radiator portion 22 having the fin width L_B larger than the fin width P_A of the first louver slats 211a of the condenser portion 21, the two portions 21 and 22 of corrugated fin 2 can have different fin widths, thereby meeting diversified demands for performance.

Incidentally, a manufacturing method of the corrugated fin 2 to correct a bend of the entire corrugated fin 2 thereafter will be explained.

When forming the corrugated fin 2, the bend of the entire corrugated fin 2 generated during the corrugating processing is thereafter corrected using a corrugated fin correcting device 4 shown in FIG. 4 in such a manner that when the corrugated fin 2 is passed through between rollers 41 which is arranged at a predetermined pitch and opposing each other, a circumferential speed of the roller inside the bending (a pitch F_2 side shown in FIG. 6A) is made faster than that of the opposing side (a pitch F_1 side shown in FIG. 6A). Consequently, as shown in FIG. 6B, a pitch F_{21} in a corrugated form inside the bending is widen to be substantially the same pitch as F_1 to correct the entire bend, and the fin width F_2 before the formation is 48 mm and the fin width F_{21} after the formation is 47.5 mm. Incidentally, the other effect and structure are the same as those of the first embodiment, so the explanation thereof is omitted.

The method thus used to correct the bend of the corrugated fin 2 can

provide the following effects in addition to the effects (1) and (2) of the first embodiment.

(5) For a composite heat exchanger 1 for motor vehicles, the condenser portion 21 and the radiator portion 22 are integrally formed next to each other to have different fin widths, and the bend of the entire corrugated fin 2 during the corrugating step is corrected thereafter by widening the wave pitch inside the bending to a predetermined width. Accordingly, the bending can be further corrected and minimized, and the two portions 21 and 22 of the corrugated fin 2 can have different fin widths, thereby meeting diversified demands for performance.

Further, this corrugated fin 2 correcting device 4 used in combination with the first embodiment and the second embodiment can limit the bending of the corrugated fin 2 with high precision, which can thus contribute to efficient manufacturing during the manufacturing step of the composite heat exchanger 1 thereafter, and to increase of the product precision of the composite heat exchanger 1.

As described above, the corrugated fin of the present invention have been explained based on the first embodiment and the second embodiment. However, the specific structure is not limited to these examples, and modification or addition of design will be tolerated without departing from the gist of the invention according to the respective claims.

For example, in the examples, the louvers are formed to be orthogonal to the air passing through the corrugated fin, but the louvers may be formed to have an angle to the air passing through the corrugated fin. In this case, the condenser side and the radiator side may have the same direction or a different direction, and may have the same angle or a different angle.

Further, when changing the wave pitch of the corrugated fin, the corrugated fin is passed through between the rollers having a predetermined width in the examples, but the corrugated fin may be pressed to lower the wave height.

The entire contents of Japanese Patent Application 2002-309952 (filed Oct. 24, 2002) are incorporated herein by reference.

The present embodiments are to be considered in all respects as illustrative and no restrictive, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein. The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof.